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Forward trading in exhaustible-resource oligopoly☆

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ABSTRACT

We analyze oligopolistic exhaustible-resource depletion when firms can trade forward contracts on deliveries – a market structure relevant for some resource markets (e.g., storable pollution permits, hydro-based power pools) – and find that trading forwards can have substantial implications for resource depletion. We show that when firms' initial resource-stocks are the same, the subgame-perfect equilibrium path approaches the perfectly competitive path as firms trade forwards frequently. But when the initial stocks differ, firms can credibly escape part of the competitive pressure of forward contracting. It is a unique feature of the resource model that equilibrium contracting and the degree of competition depends on resource endowments.

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1. Introduction

1.1. Motivation

Hotelling's (1931) theory of exhaustible-resource depletion is a building block for understanding intertemporal allocation of a finite resource stock. The theory is used in myriad of applications which, without exceptions known to us, assume implicitly or explicitly that the commodity stock is sold in the spot market only, thereby ruling out forward trading despite the fact that it is observed in many commodity markets and markets for exhaustible-stocks in particular. Forward trading is typically associated to the desire of some groups of agents to hedge risks but it can also arise in oligopoly settings without uncertainty. For the case of reproducible commodities, Allaz and Vila (1993) have already shown that when forward positions are publicly observable, and hence can be used as a commitment device, the mere opportunity of trading forward contracts forces firms to compete both in the spot and forward markets, creating a prisoner's dilemma for firms in that they voluntarily sell forward contracts (i.e., take short positions) and end up producing more and thus behaving more competitively than in the absence of the forward market.[1] In this paper we are interested in understanding whether and how this pro-competitive effect of forward contracting can also arise in an oligopolistic exhaustible-resource market.[2]

Our point of departure is that in exhaustible-resource markets the pro-competitive implications of forward contracting, as explained by Allaz and Vila (1993), cannot arise from the expansion of output as in such markets firms face an intertemporal capacity constraint coming from their finite stocks. One may then conjecture that for exhaustible resources forward contracting leaves oligopoly rents intact (e.g., Lewis and Schmalensee, 1980; Ulph and Ulph, 1989).[3] This conjecture is not correct, however. We find that, despite the resource constraint, contracting enhances competition, and that the mechanism delivering the pressure is different from that in Allaz and Vila (1993). Also, in the resource context, the equilibrium contracting and degree of competition will depend on the resource endowments as we will show. Are these insights relevant for resource commodity markets? Our main result that "speculating" with contract transactions leads to lower prices, even in the presence of a resource constraint, adds to the heated debate on whether contract trading in commodity markets, many of which are energy related, should be regulated.[4] In particular, our results provide evidence for mitigating one fear often associated with contracting, namely, that the limited supply together with contracting could enhance market manipulation; in contrast, in our setting, the contract market arises endogenously to precisely limit the market power of the sellers. Thus, while the resource scarcity will influence the equilibrium contracting, the scarcity itself will not prevent its pro-competitive effect from arising. Whether the scarcity is an issue – it may not be in the typical non-renewable resource markets one has in mind such as minerals, oil, and gas (see, e.g., Krautkraemer, 1998) – there are energy-related markets and industries where the two basic assumptions of the Hotelling model, i.e., homogeneity and finiteness of the resource, seem to hold.

One notable example where both of the Hotelling assumptions do hold is the market for SO_2 permits created under the US Acid Rain Program (Ellerman and Montero, 2007). An important feature of the SO_2 program was the tightening of future emission limits accompanied by firms' possibility to store today's unused permits for use in later periods. In anticipation of the tighter limit, it was in the firms'

[1] That a firm's forward position is observed by rivals is not only present in the theoretical literature that has followed Allaz and Vila (1993) but also in the more applied analysis of oligopolistic markets (e.g., Bushnell et al., 2008; Sweeting, 2007; Wolak, 2007), including the (exhaustible) nitrate market (Brown, 1963).

[2] Phlips and Harstad (1990) already mentioned that forward contracting can have an important effect on oligopolistic exhaustible-resource markets but they did not explain whether and to what extent firms will sign forwards in equilibrium.

[3] Both Lewis and Schmalensee (1980) and Ulph and Ulph (1989) suggest that the existence of futures markets validates the use of "path strategies", or more generally, allows firms to commit to production plans.

[4] In the US, the Dodd Frank Wall Street Reform and Consumer Protection Act 2010 changed the regulatory environment of the financial industry, including a potential cap the number of contracts a trader can have in oil, natural gas and other commodities. The following citation captures the representative concern: "If orange juice gets too pricey (perhaps because of a speculative bubble), we can easily switch to apple juice. The same does not hold with oil.", Joseph P. Kennedy II, New York Times OpEd, April 10, 2012.